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THE IMPACT OF A MIXED-MODE DATA COLLECTION DESIGN ON NON RESPONSE BIAS ON A BUSINESS SURVEY

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ABSTRACT

Many studies of data collection processes for business surveys focus on issues related to how to increase response rates and how to reduce response burden. Additionally, some have focussed on measurement error. Issues related to non response bias, on the other hand, do not seem to be explicitly part of the research agenda. The main reason why researchers should be concerned about non response is the potential for it to introduce bias. Our paper compares two alternative survey designs in terms of resultant response rates and non response bias. The first design is a simple postal survey with follow-up mailings; the second design is a two-phase multi-mode design, where the postal survey is followed at the second phase by a telephone survey of non-respondents. We found evidence that the sample obtained using only postal methods is biased in important respects. Bias is not apparent in the demographic characteristics of the employees. Bus bias is observed in some of the employees' employment characteristics and some of the characteristics of the firms in which they work. The multi mode design seems, overall, to have reduced or removed the bias of the postal sample. Only in marginal respects was some further bias introduced. We also compare costs of the two designs, to enable a comparison of cost-effective at bias reduction.

Key words: business survey, multi-mode data collection, non-response bias, survey costs, survey design

1. Introduction

Establishment surveys have to deal with methodological issues that are quite different from the ones researchers normally face while carrying out other kinds of surveys. The process of making contact and obtaining co-operation, for example, is usually longer and more complicated, while the dynamics of the response process are specific to this kind of survey (Paxson et al., 1995). Additionally, in many - perhaps most - countries a large proportion of establishment surveys are carried out by National (or Regional) Statistical Institutes (Cox et al., 1995). These surveys typically have long-established processes, participation is compulsory, and they are viewed as administrative routines rather than surveys (Smith et al., 2003). It is no surprise, therefore, that the response rates obtained for business surveys carried out by National Statistical Institutes are usually quite high and usually higher than the ones obtained for business surveys carried out by academics. Willimack et al., for example, report that the unweighted unit response rates for surveys sponsored by U. S. government statistical agencies range from 60% to over 90% (2002, p. 215).

In spite of the high response rates, researchers seem to be increasingly concerned that the general trend towards increased non response in surveys might affect also business surveys. Scholars have recently addressed their attention to how to encourage response and how to reduce response burden in the case of business surveys (Fisher et al. 2003; Fox et al. 2003; Haraldsen 2004; Kaplan and Whiter 2002; Petroni et al. 2004; Tarnai and Paxson 2004). Issues related to non response bias, on the other hand, do not seem to be explicitly part of the research agenda. The main reason why researchers should be concerned about non response is the potential for it to introduce bias. We are not aware of many studies that focus on the relationship between response rates and non response bias in the case of business

surveys (cf. Groves 2005, Keeter et al. 2000 and Curtin et al. 2000 in the case of household surveys). Even less is known about the effects of multi-mode data collection strategies on non-response bias in the case of business surveys. In the case of household surveys there is evidence that the multimode data collection design increases response and reduces non-response bias (see, for example, Gallagher et al. 2005).

The ultimate aim of our paper is to describe the effects of multiple phases of data collection, using different modes, on response rates and non response bias. In particular, we assess the relative cost-effectiveness of two alternative survey designs at minimising non-response bias on a business survey.

The paper is divided into 6 sections. We begin by describing the methodological context for the employer survey upon which our study is based (section 2), then we look at the response rates obtained at the two stages of the survey (a postal stage and a telephone stage) and we discuss reasons for refusal (section 3). We then compare the two designs in terms of non-response bias (section 4) and data collection costs (section 5). Finally we give an overall evaluation of the two stage (postal and telephone) design adopted, compared with a simple one stage postal survey with respect to non-response bias and costs (section 6).

2. The data

The employer survey upon which this paper is based is part of a large-scale methodological project known as ISMIE, Improving Survey Measurement of Income

and Employment¹. In the context of this project, a validation study was carried out. The aim was to validate data about employment conditions collected in a face-to-face household interview survey, the ISMIE survey. The validation data were to be collected by means of a subsequent survey of the employers of the persons interviewed in the household survey. It is this survey of employers that forms the basis of our study.

2.1 The ISMIE survey

The ISMIE sample consists of the 'low income' subsample of the UK part of the European Community Household Panel (ECHP) Study. All members of this sample who were successfully interviewed during the final (2001) wave of the BHPS-ECHP panel (1,163 individuals) were included in the ISMIE survey and interviews were completed with 1,033 of them. During the ISMIE survey detailed information about the employment situation of the respondents was collected. In particular respondents were asked for information about their employer (industry, workplace size), their job characteristics (occupation, employee/self-employed, managerial duties, usual working hours, working hours arrangements) and their income (last gross/net pay, hourly rates of pay, rates for overtime, availability and membership of pension schemes). The data collection took place in spring 2003.

During the interview, members of the ISMIE sample who were currently in employment (excluding the self-employed) were asked for written permission to approach their employer to request some further details of their employment. If permission was given, they were then asked to provide contact information for their

¹ For a detailed description of the aims, the research design and the methodology of the ISMIE project, see Jäckle et al. (2004). Findings from the ISMIE project are published in Lynn and Sala (2004), Lynn et al. (2004a and 2004b), Jäckle and Lynn (2004), Jenkins et al. (2004a and 2004b), Sala and Lynn (2004).

employer. The contact information requested included the name of a person within the employing organisation who would know about the nature of the ISMIE respondent's employment and pay. The names and contact details of employers provided by the ISMIE respondents constituted the sample for the consequent employer survey.

2.2 The employer survey

The employer survey was designed as a multi mode survey, with a postal stage followed by a telephone follow up of non-respondents. For a description of the employer survey, in particular with regard to the contact and response process, see Lynn and Sala (2004). At the postal stage of the employer survey questionnaires were mailed to the person who had been named by the ISMIE respondent. In a few cases where no name was provided, the questionnaire was addressed to "Human Resources". Following the initial mailing, there were two stages of reminder mailings; the first consisted of a letter and the second a re-administration of the questionnaire. At the phone stage of the survey calls were made to the phone numbers indicated by the ISMIE respondents. If no information was provided or if the phone numbers were incomplete or incorrect, telephone numbers were sought in the Internet websites of Yellow Pages, British Telecom and Google. The telephone calls aimed to encourage the employer to return the postal questionnaire or to answer the questions as a telephone interview. The employer survey was carried out between July 2003 and January 2004. The final response rate obtained for the employer survey was 71.5%.

The questionnaire that was used for the employer survey contained a subset of the questions that had been asked to the respondents in the ISMIE survey regarding their own employment situation.

3. The response process

In this section we examine the response rates obtained with the two different survey designs and we discuss the reasons for refusal. Of the 1,033 respondents to the ISMIE survey, 434 were employees, 59% of whom (254) consented to take part in the employer survey. One of the consenting employees did not provide any contact information for his employer, therefore the eligible sample consists of 253 employers.

The response status and the response rates for the employer survey are shown in Table 1. The response rate and the explicit refusal rate obtained with the postal survey design are respectively 51% and 13%. It is of course impossible to know with a postal survey what proportion of the remaining 36% are non-contacts (i.e. the addressee or target respondent never received the questionnaire) and what proportion are refusals (the addressee or target respondent chose not to return it). The 91 employers from whom no reply was received at the postal stage of the survey were then contacted by telephone. The response rate for the telephone stage (conditional upon having not responded to the postal stage) is 57% while the refusal rate is 37%.

The total response rate obtained is therefore 72%, with a refusal rate of 27% and a non-contact rate of 2%. This response rate compares favourably with many academic household surveys and with the (American) academic surveys of establishments reported in Dillman (2000, p.331) and Paxson et al. (1995, pp. 307-308).

Table 1. Response status and response rates for Employer Survey by survey designs (Numbers and rates)

Response status	Survey design		
	Postal survey	Telephone follow up	Multi mode design
<u>Numbers</u>			
Questionnaires completed	129	52	181
Refused	33	34	67
No reply	91	-	-
Non-contact	-	5	5
Total eligible	253	91	253
<u>Percentages</u>			
Response rate	51.0	57.1	71.5
Refusal rate	13.0	37.4	26.5
Non-contact rate	-	5.5	2.0

Some indication of the reasons for refusal is presented in Table 2. It should be noted that during the postal stage, these reasons were not collected in a systematic way. However, 33 employers communicated their reasons and we have coded those reasons to the categories presented in Table 2. During the telephone stage, reasons were requested and recorded systematically. Despite this caveat, and the small sample sizes involved, some indication of the causes of refusal emerges. Four main types of refusals are identified: issues related to the employees (difficulties in chasing up/checking consent with the employees; problems in checking the records of the employees), issues related to the employers (no time, lack of motivation), company policies in relation to confidential matters, and general or non-specific refusals. Company policy issues appear less prevalent at the telephone stage. This may be because most companies where this applies had already refused at the

postal stage and therefore did not enter the telephone stage. However, it could also be the case that concerns of the employers in relation to confidentiality were easier to overcome in the telephone mode.

Table 2. Reasons for Refusals by Survey Designs (Numbers)

	Postal design	Telephone follow up
General refusal/No specific reasons	9	11
Company policy and confidentiality issues	10	2
Issues related to the employees (no permission from employees, employees unknown)	10	13
Issues related to the employers (no time, no incentives)	4	5
Others	-	3
<i>Total = All explicit refusals</i>	33	34

4. Non-response bias

In this section we investigate non-response bias. We treat the data collected during the ISMIE survey as the eligible sample² and compare the employer survey responding sample under alternative designs to assess non response bias. We compare the structure of the responding samples obtained using a one mode (postal) design and a multi mode (postal plus telephone) design with the complete (attempted) sample. We aim to check if the sample obtained with the first design is biased and if the sample obtained with the multimode design reduces such bias.

² The complete sample consists of the 253 respondents who gave permission to contact their employers and who provided employer contact details.

4.1 The sample composition at the different stages of the data collection process

We assess non-response bias in terms of three sets of variables: demographic characteristics of the employees (sex, age and ethnicity), employment characteristics of the employees (whether the employees have managerial duties, weekly gross pay, weekly hours of work (including overtime), whether the respondents work overtime and type of occupation) and characteristics of the firm in which the employees work (size of the firm, sector, location of the firm).

Table 3 shows the composition of the sample with respect to the demographic variables sex, age and ethnicity of the employees. The data show that under either survey design there is no evidence of non-response bias in respect of these variables.

Table 3 Sample composition by demographic variables of the employees (column percentages)

	Postal design	Multi mode design	Total
<u>Sex</u>			
Male	37.2	44.2	41.9
Female	62.8	55.8	58.1
<u>Age</u>			
18-35	30.2	32.0	32.0
36-45	35.7	35.4	36.0
46 and over	34.1	32.6	32.0
<u>Ethnicity</u>			
White	96.9	97.2	96.4
Others	3.1	2.8	3.6
<i>Base</i>	<i>129</i>	<i>181</i>	<i>253</i>

Notes: The base for the variable ethnicity is 128 in the case of the postal sample, 180 in the case of the multimode sample and 252 in the case of the total sample. The chi square test refers to the relevant two by two tables. * $0.05 \geq P > 0.01$; ** $0.01 \geq P > 0.001$; *** $0.001 \geq P$.

The composition of the sample according to the employees' employment characteristics is shown in Table 4. The variables that we consider are: the employee's managerial duties, the gross pay per week, the total weekly hours of work, overtime work, and type of occupation³. The sample of employers responding to the postal survey looks biased with respect to managerial duties and type of occupation. Employees with managerial duties ($p=0.005$) and employees with clerical and secretarial occupations ($p=0.007$) tend to be overrepresented in the sample obtained with the postal design. The sample obtained with the multimode design reduces the bias in managerial duties ($p= 0.020$) and in the distribution of occupations. It removes, in particular, the overrepresentation of clerical and secretarial occupations though it slightly worsens the proportions of manager and administrators ($p=0.017$) and of "other occupations" ($p=0.006$). In these two last cases, the change in the statistical significance of the tests is due to both changes in the composition and in the numbers of the non respondent sample. The multimode design also seems to introduce some bias in the gross pay distribution. Employees who earn from 241 to 350 pounds a week ($p=0.011$) are more likely to be present in the sample obtained with the multi mode design.

³ The respondent's occupation is classified according to the Standard Occupational Classification (SOC) (Employment Department Group and Office of Population Censuses and Surveys, 1990).

Table 4 Sample composition by employees' employment characteristics

	Postal design	Multi mode design	Total
<i>Managerial duties</i>			
Manager	19.4**	16.6*	13.4
Foreman/Supervisor	12.4	13.3	14.2
Not manager/supervisor	68.2	70.2	72.3
Total	129	181	235
<i>Gross pay per week</i>			
Less than 149	24.4	22.9	25.7
150-240	25.2	24.0	24.5
241-350	26.8	31.4*	27.0
351 and more	23.6	21.7	22.8
Total	127	175	241
<i>Total weekly hours of work (inc. overtime)</i>			
Less than 26	24.0	22.1	23.8
27-36	21.7	19.9	19.8
37-41	31.8	30.9	29.8
42 and more	22.5	27.1	26.6
Total	129	181	252
<i>Over time work</i>			
No	65.1	61.3	60.1
Yes	34.9	38.7	39.9
Total	129	181	253
<i>Standard Occupational Classification</i>			
Managers & administrators	10.2	10.6*	8.0
Professional occupations	4.7	3.9	4.4
Associate professional & technical occupations	10.2	8.4	8.4
Clerical & secretarial occupations	23.6**	18.4	17.3
Craft & related occupations	9.4	10.6	9.2
Personal & protective service occupations	18.1	18.4	20.1
Sales occupations	7.1	10.1	10.0
Plant & machine operatives	8.7	11.7	11.2
Other occupations	7.9	7.8**	11.2
Total	127	179	249

Note. The chi square test refers to the relative two by two tables. * $0.05 \geq P > 0.01$; ** $0.01 \geq P > 0.001$; *** $0.001 \geq P$.

In Table 5 we look at the pattern of response from a different perspective. We examine the composition of the sample with respect to the characteristics of the firm in which the employees work: dimension, sector⁴ and location of the firm.

The sample obtained with the postal design seems biased with respect to the sector and the location of the firm in which the employees work. Public sector firms are more likely than private sector firms to respond to the postal survey. Firms belonging to the public administration and education sector ($p=0.005$) and firms located in the South West of England ($p=0.044$) are more likely to be over represented while firms belonging to the wholesale and retail trade sector or to the hotel and restaurant sector ($p=0.017$) or firms located in the West Midlands ($p=0.002$) are more likely to be underrepresented. The multi mode design removes the bias associated with sector and with SIC distribution. Overall, it also reduces the bias in the distribution of the location of the firm. [The change in significance of the estimate of firms located in East Anglia and East Midlands is entirely due to the change in the size of the responding sample.] Furthermore, the multimode design introduces some bias in the distribution of the size of the firm. Small firms are less likely to be represented than in the total sample.

⁴ The industry sector of the respondent's employer is measured by the Standard Industrial Classification (SIC) (Central Statistical Office, 1992). The variable "sector" presented in Table 5 is derived from the variable "Standard Industrial Classification".

Table 5 Sample composition by firm characteristics (column percentages)

	Postal design	Multi mode design	Total
<i>Size of the firm</i>			
Less than 24 employees	30.2	27.1**	32.0
25-99 employees	27.1	29.3	27.7
100 and more employees	42.6	43.6	40.3
<i>Standard Industrial Classification (SIC)</i>			
A, C	1.7	1.8	1.7
D, F, I	22.5	23.2	24.1
G, H	17.5*	23.2	24.1
J, K	11.7	14.3	12.2
L, M	21.7**	16.7	15.2
N, O	24.2	20.2	21.5
P	.8	.6	1.3
<i>Sector</i>			
	**		
Public	45.8	36.9	36.7
Private	54.2	63.1	63.3
<i>Location of the firm</i>			
London and South East	25.0	24.4	23.0
South West	16.4*	14.4	12.3
East Anglia, East Midlands	11.7	11.7*	15.1
West Midlands	5.5**	9.4	11.5
North	25.0	23.3	22.6
Wales	3.9	3.3	3.6
Scotland	12.5	13.3	11.9
<i>Base</i>	<i>129</i>	<i>181</i>	<i>253</i>

Note: Due to item non response, the base in some cases is smaller. SIC sections: A: Agriculture, Hunting and Forestry; C: Mining and Quarrying; D: Manufacturing; E: Electricity, Gas and Water Supply; F: Construction; G: Wholesale and Retail Trade; H: Hotels and Restaurants; I: Transport, storage and Communication; J: Financial Intermediation; K: Real Estate, Renting and Business Activities; L: Public Administration and Defence; M: Education; N: Health and Social Work; O: Other Community, Social and Personal Service Activities, P: Private Households with Employed Persons. * 0.05 ≥ P > 0.01; ** 0.01 ≥ P > 0.001; *** 0.001 ≥ P.

To sum up, the analyses carried out so far have shown that the sample obtained at the postal stage of the data collection seems to be biased in important respects. Bias is not apparent in the demographic characteristics of the employees. But bias is observed in some of the employees' employment characteristics and some of the characteristics of the firms in which they work. The multi mode design seems, overall, to have reduced or removed the bias of the postal sample. Only in marginal respects was some further bias introduced by the telephone phase.

4.2 Logit models of response propensity

The limitation of the analyses that we have just described is that they do not take into account the relationships between the variables. In order to disentangle the role played by each single variable in the analysis of non response bias, net of the effects of the others, we developed two different logit models. The first one models the probability of response for the single mode design, the second one models the probability of response for the multi mode design. The results of the regressions are summarised in Table 6.

When we focus on the postal design, we find support for the results of the bivariate analyses of non response described in the previous section. There are, in particular, three features that stand out very clearly. The sample obtained with the postal design does not appear biased with respect to the demographic characteristics of the employees. The postal sample is biased with respect to some of the employees' employment characteristics, in particular with respect to managerial duties and, even if to a lesser extent, to the type of occupation of the employees. Other things being equal, the odds of employees who are not a manager or supervisor being represented in the postal sample are about 20% those of employees with managerial duties. Compared to employees in clerical and secretarial occupations, employees

who have occupations related to personal and protective service or who have “other” types of occupations have odds ratios of about $\frac{1}{4}$ of being present in the postal sample. Moreover, the characteristics of the respondent sample differ significantly from those of the non respondent sample with respect to the sector and to the location of the firm. *Ceteris paribus*, firms that belong to the wholesale and retail trade sector and to the hotel and restaurants sector are less likely to answer the postal questionnaire than firms in the public administration, defence and education sectors (odds ratio 0.17). Firms involved in financial intermediation, real estate, renting and business activities are also less likely to respond to the postal survey than firms in the public administration, defence and education sectors (odds ratio 0.27). Firms located in the South West, in the North and in Scotland have much higher odds than firms located in the West Midlands to be represented in the postal survey sample.

With the multi mode data collection design, there is a much weaker association of the odds of responding with the covariates examined here. There is again no evidence of differential response with respect to the demographic characteristics of the respondents. Moreover, the multi mode design has removed the bias associated with the employment characteristics present in the first stage of the data collection process (managerial duties, SOC). The only significant associations with response propensity that remain are related to the firm characteristics of the employees, the size of the firm and, to a lesser extent, the sector of the firm. Large firms (more than 25 employees) are more likely than small firms to respond to the multi mode design (odds ratio greater than 3.0) while firms in the manufacturing, construction and transport, storage and communication sectors are less likely than firms in the public administration, defence and education sectors to be present in the sample obtained with the multimode design (odds ratio 0.20).

As suggested by the values of the goodness of fit, the two models are not able to describe fully the dynamics of the non-response in establishment surveys. The covariates examined here explain only a modest proportion of the variation in response propensity. Considering the importance of these variables for much analysis of business survey data, this is rather good news, suggesting that non-response error in key survey estimates may tend to be small in magnitude. The non-response seems rather to depend on some unobservable characteristics (such as perhaps the good will and time availability of the person/s who have to fill in the questionnaire).

Table 6 Odds ratios from logistic regression

Independent variables	Postal design	Multi mode design
<u>Demographic characteristics</u>		
Sex (baseline: male)		
Female	1.419	0.685
Age (baseline: 18-35)		
36-45	1.222	1.271
46 and over	1.233	1.734
<i>Ethnicity</i> (baseline: white)		
Others	0.452	0.401
<u>Employees' Employment characteristics</u>		
<i>Managerial duties</i> (baseline: manager)		
Foreman/Supervisor	0.171*	0.315
Not manager/supervisor	0.195*	0.448
<i>Gross pay per week</i> (baseline: Less than £149)		
£150-240	0.942	1.203
£241-350	0.734	2.392
£351 and more	0.665	0.652
<i>Total weekly hours of work (normal plus overtime)</i> (baseline: Less than 26)		
27-36	1.289	1.379
37-41	0.796	0.657
42 and more	0.529	0.629

<i>Over time work</i> (baseline: No)		
Yes	0.639	0.591
<i>Standard Occupational Classification</i> (baseline: Clerical and secretarial occupations)		
Managers & administrators	0.376	6.554
Professional occupations	0.575	0.930
Associate professional & technical occupations	0.333	1.314
Craft & related occupations	0.750	4.652
Personal & protective service occupations	0.263*	0.669
Sales occupations	0.497	1.637
Plant & machine Operatives	0.625	2.826
Other occupations	0.272*	0.308
<u>Firm characteristics</u>		
<i>Size of firm</i> (baseline: Less than 24 employees)		
25-99 employees	1.063	3.426*
100 and more employees	1.136	3.238**
<i>Standard Industrial Classification</i> (baseline: L, M)		
A, C	0.608	0.911
D, F, I	0.360	0.195*
G, H	0.171**	0.393
J, K	0.273*	1.293
N, O	0.524	0.607
P	0.163	0.070
<i>Location of the firm</i> (baseline: West Midlands)		
London and South East	3.229	1.714
South West	4.162*	2.594
East Anglia, East Midlands	1.608	0.580
North	3.264*	1.517
Wales	2.332	0.690
Scotland	3.790*	2.096
Pseudo R ²	0.152	0.195
N	223	223

Note: SIC sections: A: Agriculture, Hunting and Forestry; C: Mining and Quarrying; D: Manufacturing; E: Electricity, Gas and Water Supply; F: Construction; G: Wholesale and Retail Trade; H: Hotels and Restaurants; I: Transport, storage and Communication; J: Financial Intermediation; K: Real Estate, Renting and Business Activities; L: Public Administration and Defence; M: Education; N: Health and Social Work; O: Other Community, Social and Personal Service Activities, P: Private Households with Employed Persons. * 0.05 ≥ P > 0.01; ** 0.01 ≥ P > 0.001; *** 0.001 ≥ P.

5. Data Collection Costs

An assessment of the efficiency of the two survey designs requires also an evaluation of the data collection costs associated with each of them. In this section, we provide some limited information on the marginal costs of data collection associated with each survey design⁵.

In Table 7 we summarise our estimates of the costs of data collection. For the multimode survey design, the realised mean cost of data collection per respondent employer was € 21.4. It would have been € 5.6 if we had only carried out the postal survey. These figures exclude costs of data entry, data processing and researcher time, as we assume these to be independent of the mode of data collection.

Table 7 Sample composition by firm characteristics (column percentages)

	Postal design	Telephone follow up	Multimode design
Issued sample	253	91	253
Unit cost per issued	2.8	34.6	15.3
Respondent sample	129	52	181
Unit cost per respondent	5.6	60.6	21.4

Note: The costs are expressed in Euro.

6. Conclusions

As we stated in the introduction, many researchers who carry out business surveys seem to be mainly concerned with response rates and how to increase them. In spite of this, there is very little evidence that shows that in the case of business surveys the increase in response rates is associated with a decrease in non response bias.

Our study, in line with previous findings for household surveys (Gallagher et al. 2005), has shown that improving response rates also reduces non response bias. The efforts and the costs associated with the data collection process prove, therefore, to be successful in terms of increasing the representativeness of the sample. In our business survey we found clear evidence of non-response bias in the first phase of the data collection. Bias was not evident with respect to the demographic characteristics of the employees, but it was associated with some of the employees' employment characteristics (occupation and managerial duties) and with firms' characteristics (industry classification and location of the firm). The telephone stage reduced or removed most of these biases, though some bias remained.

Overall, we can therefore conclude that the adoption of the multimode data collection design was effective in reducing non-response bias, especially the bias related to the employees' employment characteristics, though it did not remove bias completely. The reduction of the bias was not without cost. The unit cost of data collection per respondent employer increased from 5.6 euro for the postal survey to 21.4 euro for the multimode data collection. Survey designers have to be aware that the reduction of non response bias has very high costs. Such costs mainly depend on the type of multimode data collection design adopted.

5 See Lynn and Sala (2004) p. 26-27 for further details of how the costs were estimated.

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